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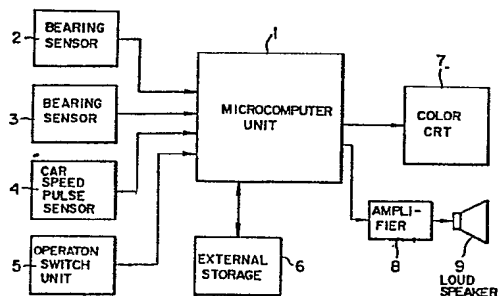
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54 **Navigation system with capability of instructing running direction.**

57 A navigation system for displaying, on a display screen (100), road map information and running traces of a car superimposed thereon comprises a cathode ray tube (7) for displaying the road map information and information regarding the car running traces and the like, bearing sensors (2, 3) for detecting a running direction of the car, a detector (4) for detecting a running distance of the car by detecting a revolution of the car wheel, and a controller (1, 5, 6, 8, 9) receiving outputs from the bearing sensors and the running distance detector, for computing a current position of the car and selecting road map information corresponding to the current position for display thereof on the cathode ray tube. The controller sets specified circular areas (109 to 112) centered on respective crossings (105 to 108) on the road map information, detects arrival of the car at the entrance (122; 115) to a specified area (111; 109), determines an angular difference between an approaching running direction of the car and a destination bearing at the entrance, and gives, on the basis of the determined angular difference, a voice instruction for running of the car at the crossing to the driver.

FIG. 1



NAVIGATION SYSTEM WITH CAPABILITY
OF INSTRUCTING RUNNING DIRECTION

1 This invention relates to a navigator in which
road map information is displayed on a cathode ray tube
(hereinafter referred to as CRT) and running trace and
direction of an automobile are displayed by being
5 superimposed on the road map information.

Such a navigator is useful to practice an
easy running of an automobile toward a destination even
when the automobile runs in an area with which the driver
is unfamiliar.

10 In the past, a navigation system has been known
in which road map information is displayed on a CRT,
and as an automobile runs, a computation data, indicative
of a running trace of the automobile and computed by a
microcomputer on the basis of data from a bearing sensor
15 for inputting running bearings of the automobile to the
system and from a car speed pulse sensor, is displayed
by being superimposed on the road map information. This
navigation system can however display only results of
running when the automobile is practically driven. Accord-
20 ingly, in order to correctly reach a destination in an
area with which the driver is unfamiliar, the driver
must constantly be acquainted with the direction of the
destination and especially, a judgement as to whether
the automobile should run straight forwardly, turn to
25 the left or turn to the right at crossings is left up to

1 the driver. For these reasons, the navigation system is
less effective to serve as a navigator. Another
navigator intended to cope with these drawbacks has
been known as disclosed, for example, in Japanese Patent
5 Application Laid-open No. 26214/1983 entitled "Running
Information System". According to this latter navigator,
voice instructions are issued to indicate a straight-
forward, turn-to-the right or turn-to-the left running
at crossings, and the driver can advantageously be
10 instructed. To perfect the above operation, prior to
driving, the driver must key-in or input to the system
turn-to-the left, turn-to-the right and straightforward
running instructions in respect of all the crossings
on a road map by using a keyboard. This preparatory
15 operation, however, becomes extensive in proportion to
an increase in distance to a destination, and imposes
a great labor on the driver and hence is time consuming.

This invention therefore contemplates elimi-
nation of the above prior art drawbacks and has for its
20 object to provide a navigation system capable of
issuing voice instructions which apprise the driver of
car running directions at crossings through a preparatory
operation carried out within a reduced time.

According to this invention, the above object
25 can be accomplished by a navigation system wherein for
detection of crossings on a road map, a specified cir-
cular area centered on each of the crossings is set,
and when a car reaches a particular circular area

1 associated with a particular crossing, a running direction
at that crossing is automatically determined by computing
a destination bearing and a running direction of the car
when it approaches that area (hereinafter simply referred
5 to as approaching running direction), thereby simplifying
the key-in operation prior to driving. Thus, the inven-
tion is featured by means for setting specified circular
areas centered on respective crossings on road map
information and detecting a car which reaches a parti-
10 cular specified circular area, computing means for
computing an angular difference between an approaching
running direction and a destination bearing at an entrance
to the particular circular area, and running direction
instructing means responsive to computation results for
15 issuing voice instructions which apprise the driver of
a running direction of the car at a crossing associated
with the particular area.

The present invention will be apparent from
the following detailed description taken in conjunction
20 with the accompanying drawings, in which:

Fig. 1 is a block diagram schematically showing
the overall construction of a navigation system according
to an embodiment of the invention;

Fig. 2 shows a layout of individual switches
25 on an operation panel;

Fig. 3 is a block diagram showing details of a
microcomputer used in Fig. 1;

Fig. 4 shows an example of a display of road

1 map information which is useful for explaining the principle of the invention;

Fig. 5 shows running zones defined by referencing to a destination bearing; and

5 Fig. 6 is a diagram for explaining an example of computation for the destination bearing and a running bearing.

Referring to Fig. 1 illustrating the overall construction of a navigation system according to an embodiment of the invention, there is seen a micro-computer unit 1 which is the heart of the present navigation system and which controls the operation of the entire system. Details of the microcomputer unit 1 will be described later with reference to Fig. 3.

15 A bearing sensor 2 for detecting an absolute bearing of a car running direction utilizes earth magnetism and provides amplified analog quantities representative of its X and Y components.

Like the bearing sensor 2, a bearing sensor 3, 20 for example, in the form of an optical fiber sensor detects a car running direction but provides an output representative of a relative bearing.

A car speed pulse sensor 4 generates an ON-OFF pulse corresponding to a car speed which in turn is 25 inputted, as a signal representative of a running distance of the car, to the microcomputer unit 1 of the navigation system.

An operation switch unit 5 is adapted for

1 inputting various running conditions of the car to the
microcomputer unit 1 and includes a plurality of switches
which are used for inputting to the various running
conditions as a digital signal.

5 An external storage 6 stores road map information and various running conditions and takes the form of, for example, a cassette tape controlled by the microcomputer unit 1.

A color CRT 7 serving as a means for displaying
10 the road map information and the like stored in the external storage 6 is controlled by an output of a color CRT control circuit included in the microcomputer unit 1.

An amplifier 8 amplifies a voice signal and
15 cooperates with a loudspeaker 9 to provide voice instructions which apprise the driver of the running information.

The operation switch unit 5 shown in Fig. 1 includes a plurality of operation switches as shown in
20 Fig. 2. A setting switch 11 is adapted to set a running start point and a running destination during initialization of the navigation system. A switch 12 cooperative with the setting switch 11 is operated so as to set the running destination of the car. A position switch 13
25 cooperative with a correction switch 19 is adapted to correct a current position of the car. A bearing switch 14 also cooperative with the correction switch 19 is adapted to correct the bearing sensors 2 and 3 adapted

1 to detect the running direction of the car. A group
of switches 15 to 18 are used to set and move cursors
which indicate a current position of the car displayed
on the color CRT 7. The cursors can be moved in any
5 directions labelled to the respective switches 15 to 18.
For example, when the switch 15 labelled with north is
pushed down, a first cursor (a cursor line extending
to an X-axis) is moved from the current position to the
north. With depression of the switches 16, 17 and 18,
10 a second cursor (a cursor line extending to a Y-axis)
is moved to the west, the first cursor to the south and
the second cursor to the east, respectively.

Details of the microcomputer unit 1 shown in
Fig. 1 are illustrated in Fig. 3. A microprocessor 31
15 is the heart of the microcomputer unit 1 and controls
the operation thereof. A RAM (volatile memory) 32 is
used for temporary storage of data in the course of the
computation and control operation by the microprocessor
1. A battery carried on the car and independent of a
20 system power supply feeds the RAM 32 and contents stored
therein are kept alive even when the system power is
turned off.

A ROM (non-volatile memory) 33 stores programs
necessary for various control operations and computation
25 operations by the microprocessor 1. An input/output
control LSI (large scale integrated circuit) 34 is
adapted to input various data from interfaces 36 to 39
to the microprocessor 1. The interfaces 36 to 39 are

1 for level conversion and waveform shaping of signals.

The bearing sensor 2 is connected to the interface 36,
the bearing sensor 3 to the interface 37, the car speed
pulse sensor 4 to the interface 38, and the operation

5 switch unit 5 to the interface 39. A control LSI for
small magnetic tape device (hereinafter referred to as
CMTC) 35 controls input/output of control signals and
data (such as road map information and various running
conditions) occurring between the external storage 6 in

10 the form of the small magnetic tape device and the micro-
processor 31. An interface 40 effects signal processing
necessary for steady transmission/reception of signals
between the CMTC 35 and the small magnetic tape device.

An LSI 41 which is the heart of a circuit for
15 transmission of various display data to the color CRT 7
controls all contents of the display data. The LSI 41
is simply referred to as CRTC 41.

A timing signal generator 42 generates a
reference clock signal to the CRTC 41, a clock signal
20 in the form of a serial signal to be transmitted to a
video controller, and a timing signal which controls
gating (open or close) of a multiplexer 43.

The multiplexer 43 is responsive to the timing
signal of the timing signal generator 42 to switch a
25 address signal from the microprocessor 31 and an address
signal from the CRTC 41.

Graphic memories 44 to 46 for data of primary
colors, red, blue and green, to be displayed on the color

1 CRT 7 are accessible, through the multiplexer 43, to
the microprocessor 31 and the CRTC 41 for reading and
writing, thus combining the three primary colors to
provide display of 8 kinds of graded color data.

5 A character memory 47 dedicated to storage of
character information to be displayed on the color CRT 7
is also accessible, through the multiplexer 43, to the
microprocessor 31 and CRTC 41 for reading and writing.

A character generator 48 stores patterned
10 information of characters such as alphabetical letters,
numerals, symbols or Katakana letters and responds to
outputs of the CRTC 41 and character memory 47 to select
and deliver one of various character patterns stored.
Converters 49 to 52 operate in synchronism with the
15 timing signal generated from the timing signal generator
42 to convert parallel data outputted from the graphic
memories 44 to 46 and character generator 48 into serial
data.

The video controller 53 effects level conver-
20 sion and waveform shape processing of outputs from the
parallel to serial data converters 49 to 52 so that these
outputs meet a specification required for the color CRT
7. For data transmission, the video controller 53 is
connected to the color CRT 7.

25 An interface 54 aids in the transmission of
voice data to the loudspeaker 9 via the amplifier 8.

The operation of the navigation system having
the construction described above will be described.

1 An example of road map information displayed on
a color CRT screen 100 as shown in Fig. 4 is useful to
explain the principle of the present invention. Also
shown in Fig. 5 are running zones about a crossing which
5 are selected in accordance with an angular difference
between an approaching running direction and a destina-
tion bearing of the car which is measured counterclockwise
with respect to 0° reference of the destination bearing.

 In Fig. 4, displayed on the screen 100 of the
10 color CRT 7 are roads 101 to 104, crossings 105 to 108
of the roads on a road map, circular areas 109 to 112
centered on the crossings, intersections 113 to 128
on boundary of the respective circular areas 109 to 112
and the respective roads, a running start point 129,
15 and a destination 130. The destination 130 is outside
the color CRT screen 100, indicating that this destina-
tion is far away.

 When an ignition switch is turned on, the Fig.
3 system inclusive of the microprocessor 31 is started
20 and initialized in accordance with an initializing program
stored in the ROM 33. As a result, the system is ready
for receiving commands issued by operating the switches
on the operation switch unit 5. Under this condition,
desired one or ones of the switches 15 to 18 are operated
25 to issue signals which, after subjected to the waveform
shaping by the interface 39, are fetched by the micro-
processor 31 via the input/output LSI 34. Pursuant to
block codes dividing the whole country of Japan, the

1 signals issued from the switches 15 to 18 after initialization are respectively used to increase the column number, to decrease the row number, to decrease the column number, and to increase the row number. The
5 microprocessor 31 then sends to the CMTC 35 an instruction for calling road map information selected by the setting of the switches 15 to 18, and this call instruction is sent to the external storage 6 via the interface 40. Based on this instruction, the road map information
10 is read from the external storage 6 and written into the graphic memories 44 to 46 via the interface 40 and CMTC 35 under the control of the microprocessor 31. Data of the graphic memories 44 to 46 are sent to the data converter 49 to 51 under the control of the CRTC 41 and
15 subjected to parallel to series conversion at the timing of the timing signal generated from the timing signal generator 42. The thus obtained serial data is sent to the color CRT 7 via the video controller 53.

The driver then operates the switches 15 to 18
20 to move the first and second cursors on the displayed road map information, thereby setting a running start position at an intersection on the cursors. Thereafter, with the setting switch 11 operated, the running start point 129 shown in Fig. 4 is written into a particular
25 address of the RAM 32 via the interface 39 and input/output LSI 34 under the control of the microprocessor 31.

Subsequently, road map information containing

1 the destination 130 shown in Fig. 4 is displayed on the
screen of the color CRT 7 in a similar manner that the
running start point is set and thereafter, the driver
operates the switches 15 to 18 to set the destination
5 130 at an intersection on the cursors. At this time,
the destination setting switch 12 is operated so that
data for the destination 130 is written into a particular
address of the RAM 32 under the control of the micro-
processor 31. After the running start point and desti-
10 nation have been fetched by the system, the microprocessor
31 computes distances in terms of X and Y coordinates
between the running start point 129 and the destination
130 as well as a bearing of a straight line connecting
from the running start point 129 to the destination 130.
15 Thereafter, the distances and the destination bearing
are stored into a particular address of the RAM 32.

After completion of the above operations,
as the car starts to run, as shown in Fig. 4, from the
running start point 129 to the destination 130 along
20 the road 102, signals from the bearing sensors 2 and 3
undergo waveform shaping at the interfaces 36 and 37
in accordance with a period of a pulse from the car speed
pulse sensor 4 and are sent via the input/output LSI 34
to the microprocessor 31 where they are computed to
25 determine a bearing data which in turn is stored in a
particular address of the RAM 32. A running distance is
determined by counting and computing for a predetermined
time the number of transmissions of the signal from the

1 car speed pulse sensor 4 to the microprocessor 31 via
the interface 38 and input/output LSI 34. A result of
computation is stored in a particular address of the
RAM 32.

5 The microprocessor 31 computes a running trace
on the basis of the bearing data and running distance
data, and a computation result is written in the graphic
memories 44 to 46. Running trace data written in the
graphic memories is displayed on the color CRT 7 in
10 the same manner as the road map information. When
preparing the road map, the circular areas 109 to 112
shown in Fig. 4 are specifically set as white data, i.e.,
data being not displayed on the display screen to provide
an area of a radius of 50 m centered on each of the
15 crossings 105 to 108. When the car running from the
running start point 129 to the crossing 107 along the
road 102 reaches the intersection 122 on the boundary
of circular area 111 and the road 102, the microprocessor
31 computes an approaching running direction or bearing
20 of the car based on outputs of the bearing sensors 2 and
3, and a destination bearing of the destination 130 as
viewed from the intersection 122.

To explain results of the above computation,
the destination bearing is taken as a reference of 0°
25 as shown in Fig. 6. Since, in Fig. 6, the destination
bearing as viewed from the intersection 122 is denoted
by 131 and the approaching running direction of the
car at the intersection 122 is denoted by 122, the angular

1 difference between the destination bearing 131 and the
approaching running direction 132 is 90° in this example.

Three zones are principally defined with
respect to the destination bearing of 0° as shown in
5 Fig. 5. More specifically, a straightward running zone
is defined by the angular difference between the destination bearing 131 and approaching running direction 132 which is less than 30° and larger than 330° , a
turn-to-the right running zone is defined by the angular
10 difference which is larger than 31° and is not greater
than 180° , and a turn-to-the left running zone is defined
by the angular difference which is larger than 180° and
is not greater than 330° . Referring to Figs. 5 and 6,
since the angular difference between the destination
15 bearing 131 and approaching running direction 132 at
the intersection 122 is 90° in this example, this angular
difference is applied to the Fig. 5 zone classification
to determine the turn-to-the right running zone. When
the computation is effected to select one of the zones
20 shown in Fig. 5, the microprocessor 31 selects a code
representative of the determined zone from codes representative of straightforward, turn-to-the right and
turn-to-the left runnings which are stored in the ROM 33,
and sends the selected code via the input/output LSI 34
25 and interface 54 to the amplifier 8, so that the loud-
speaker 9 apprizes the driver of a voice instruction
corresponding to the selected code. In this example,
the angular difference between the destination bearing

1 and approaching running direction falls within the turn-
to-the' right zone and hence the driver is apprized of
a voice instruction "please turn to the right". Under
this condition, the driver turns the car to the right
5 at the crossing 107 and causes the car to enter the
road 101. Since in this embodiment the approaching
running direction and destination bearing are systematical-
ly computed when the car reaches the entrance to the
circular area, no computation is effected at the inter-
10 section 121, i.e., exit from the circular area and the
next computation and comparison will be effected in
respect of a destination bearing and an approaching
running direction at the intersection 115. At the
intersection 115, the angular difference between the
15 approaching running direction and destination bearing
approximates 0° , and the driver is apprized of a voice
instruction "Please go stragithforwardly" from the loud-
speaker 9.

As described above, the navigation system
20 according to the present invention is advantageous in
that since the guiding function gives a voice instruc-
tion for running at a crossing to the driver 50 m before
the crossing on the road map information, drive labor
imposed on the driver can be reduced considerably, that
25 since the preparatory operation necessary for the above
operation can be completed by setting only a destination
without requiring sophisticated key switch operations,
the driver can be freed from considerable labor and

- 1 time for the preparatory operation, and that labor and time required for the driver to operate key switches can be fixed and minimized irrespective of the distance to the destination.

1 CLAIMS:

1. A navigation system for displaying, on a display screen (100), road map information and running traces of a car superimposed thereon comprising:
 - 5 a cathode ray tube (7) used as a display means for displaying the road map information and information regarding the car running traces and the like;
at least one bearing sensor (2, 3) for detecting a running direction of the car;
 - 10 running distance detector means (4) for detecting a running distance of the car; and
control means (1, 5, 6, 8, 9) receiving output signals from said bearing sensor and running distance detector means and computing a current position of the
 - 15 car, for controlling car running information such as the road map information, running trace and running bearing corresponding to the current position of the car and displaying the car running information on said cathode ray tube,
 - 20 said control means including:
external storage means (16) for storing the road map information and the car running information;
a central control unit (1) for controlling said external storage means, computation of the current
 - 25 position of the car and display of the road map information; and
means (8, 9) for instructing the driver in running direction,

1 whereby specified circular areas (109 to 112)
centered on respective crossings (105 to 108) on said
road map information are set, arrival of the car at an
entrance (122; 115) to a specified area (111; 109) is
5 detected, an angular difference between an approaching
running direction of the car and a destination bearing
at the entrance is determined, and the determined angular
difference causes said running direction instructing
means to apprise the driver of a running direction at a
10 crossing (107; 105).

2. A navigation system according to Claim 1,
wherein said running direction instructing means gives
a voice instruction to the driver.

3. A navigation system according to Claim 2,
15 wherein said running direction instructing means comprises
a loudspeaker (9) for issuing the voice instruction.

4. A navigation system according to Claim 1,
wherein the angular difference between the approaching
running direction of the car and the destination bearing
20 is referenced to the destination, and a straightforward
running is decided when the angular difference falls
within $\pm 30^\circ$.

5. A navigation system according to Claim 4,
wherein a turn-to-the left running is decided when the
25 angular difference falls within a range of from 30° to
 180° , and a turn-to-the right running is decided when
the angular difference falls within a range of from
 180° to 330° .

- 1 6. A navigation system according to Claim 1,
wherein said specified circular area centered on said
crossing has its boundary which is distant a predetermined
distance from said crossing.
- 5 7. A navigation system according to Claim 6,
wherein the boundary of said specified circular area is
50 m distant from said crossing.

FIG. 1

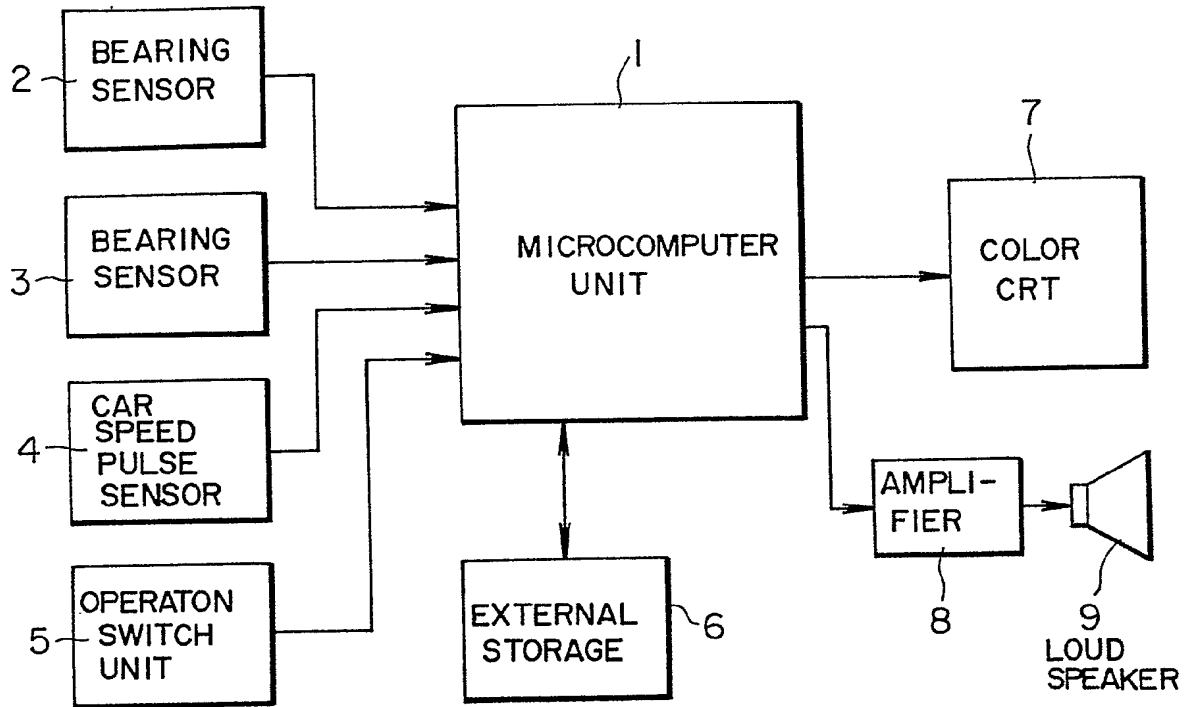
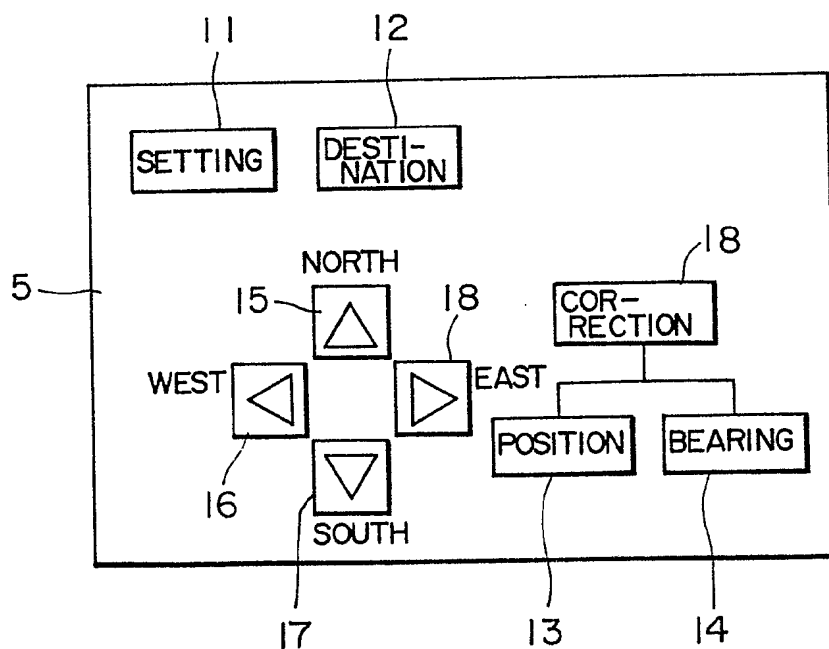


FIG. 2



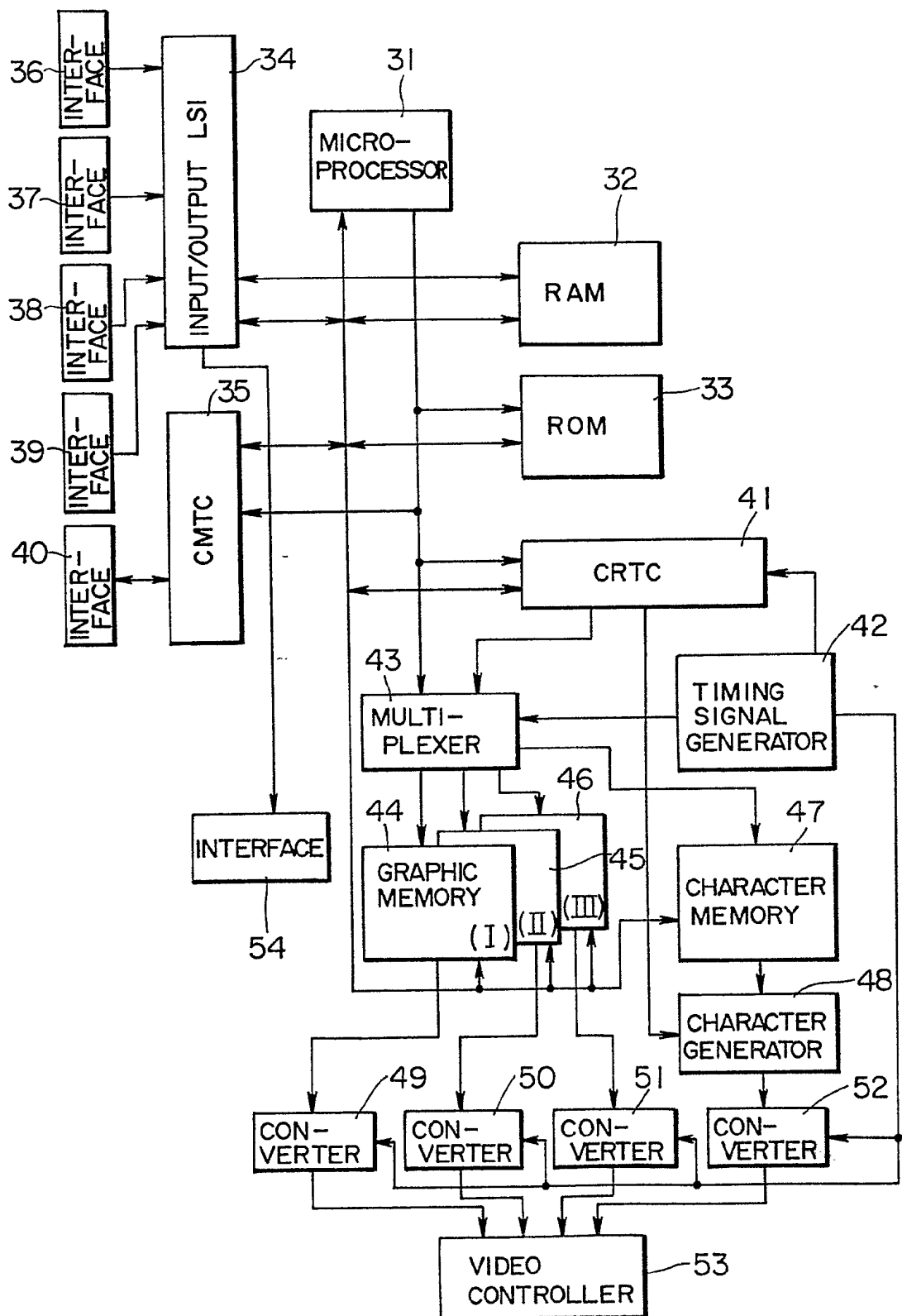
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FIG. 3

FIG. 4

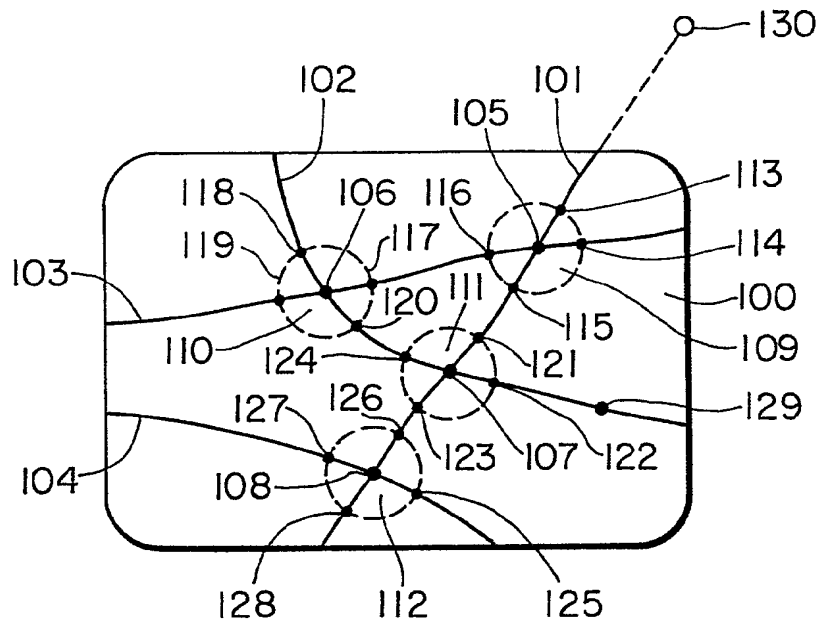


FIG. 5

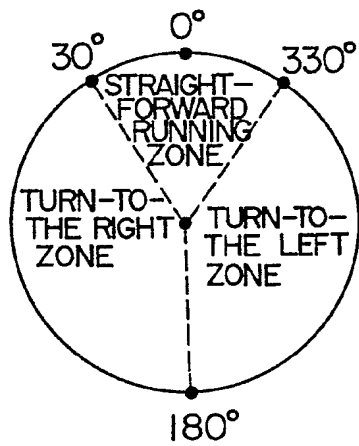


FIG. 6

